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Alternative Cropping Systems with Limited Irrigation

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Alternative Cropping Systems with Limited Irrigation

Abstract

A limited irrigation study involving four cropping systems and evaluating four crop rotations was initiated in 2012 at the Southwest Research-Extension Center near Tribune, KS. The cropping systems were two annual systems (continuous corn [C-C] and continuous grain sorghum [GS-GS]) and two 2-year systems (corn-grain sorghum [C-GS] and corn-winter wheat [C-W]). In 2019, corn yields were similar for all rotations, although averaged across the past 7 years, corn yields were greater following wheat than following corn. There were no significant differences in grain sorghum yields in 2019, which was similar to the multi-year average. Wheat yields were greater than the multi-year average.

Keywords

Corn, grain sorghum, winter wheat, deficit irrigation, irrigated crop rotations

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Cover Page Footnote

The project was funded in part by the Western Kansas Groundwater Management District No. 1.

This cropping and tillage systems is available in Kansas Agricultural Experiment Station Research Reports: https://newprairiepress.org/kaesrr/vol6/iss8/6

K-STATE Research and Extension

2020 SWREC Agricultural Research

Alternative Cropping Systems with Limited Irrigation

A. Schlegel and D. Bond

Summary

A limited irrigation study involving four cropping systems and evaluating four crop rotations was initiated in 2012 at the Southwest Research-Extension Center near Tribune, KS. The cropping systems were two annual systems (continuous corn [C-C] and continuous grain sorghum [GS-GS]) and two 2-year systems (corn-grain sorghum [C-GS] and corn-winter wheat [C-W]). In 2019, corn yields were similar for all rotations, although averaged across the past 7 years, corn yields were greater following wheat than following corn. There were no significant differences in grain sorghum yields in 2019, which was similar to the multi-year average. Wheat yields were greater than the multi-year average.

Experimental Procedures

A crop rotation study under sprinkler irrigation at the Kansas State University Southwest Research-Extension Center near Tribune, KS, was initiated in the spring of 2012. The study evaluates four different crop rotations with a limited irrigation allocation. The rotations include 1- and 2-year rotations. The crop rotations are 1) continuous corn; 2) corn-winter wheat; 3) corn-grain sorghum; and 4) continuous grain sorghum (a total of 6 treatments). All rotations are limited to 10 inches of irrigation water annually. All crops are grown no-till, while other cultural practices (hybrid selection, fertility practices, weed control, etc.) are selected to optimize production. All phases of each rotation are present each year and replicated four times. Irrigations are scheduled to supply water at the most critical stress periods for the specific crops and limited to 1.5 inches per week. Soil water is measured at planting, during the growing season, and at harvest in 1-ft increments to a depth of 8 ft. Grain yields are determined by machine harvest. Nitrogen fertilizer (UAN) was surface-applied (stream) in March to all crops (240 lb N/a for corn, 160 lb N/a for sorghum, and 120 lb N/a for wheat). Corn was planted on April 29, 2019, and harvested on September 26, 2019. Grain sorghum was planted on June 7, 2019, and harvested on October 19, 2019. Wheat was planted on September 27, 2018, and harvested on June 28, 2019.

Results and Discussion

Wheat yields in 2019 (74 bu/a) were greater than the long-term average (53 bu/a) (Tables 1 and 2). Precipitation was near normal from April through September (12.49 inches in 2019 vs. normal of 12.93 inches). Corn yields in 2019 were slightly greater than the long-term average with no differences among rotations. Grain sorghum yields were slightly below the long-term average with no differences among rotations.

On average, corn yields are greatest following wheat and least following corn, with little differences in grain sorghum yields following corn or sorghum (Table 2).

Available soil water at corn and sorghum planting and harvest was similar for all rotations in 2019 (Table 3). Precipitation delayed sorghum harvest in 2018 resulting in greater available soil water at sorghum harvest, causing less fallow accumulation following sorghum than corn. Averaged across the 7-year period, fallow accumulation prior to corn was greater following wheat than following sorghum or corn; however, fallow efficiency was greatest following sorghum (shortest fallow period). There were no differences in fallow accumulation or efficiency for grain sorghum following corn or sorghum. There were no differences in crop water use due to rotation for either crop.

Acknowledgement

The project was funded in part by the Western Kansas Groundwater Management District No. 1.

Table 1. Grain yield of three crops under limited irrigation as affected by rotation in 2019

Rotation	Corn	Wheat	Sorghum
	bu/a		
Continuous corn	185	---	---
Corn-wheat	226	74	---
Corn-sorghum	191	---	125
Continuous sorghum	---	---	130
$LSD_{0.05}$	40	---	22
ANOVA (P > F)			
System	0.088	---	0.571

LSD = least significant difference.
ANOVA = analysis of variance.

Table 2. Grain yields of three crops under limited irrigation as affected by rotation across years 2013–2019

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	176 b	---	---
Corn-wheat	201 a	53	---
Corn-sorghum	188 ab	---	137
Continuous sorghum	---	---	135
$LSD_{0.05}$	17	---	7
ANOVA (P > F)			
System	0.037	---	0.320

LSD = least significant difference.
ANOVA = analysis of variance.

Table 3. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation, Tribune, KS, 2019

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	10.90 b	15.02	11.06	26.30	4.13 a	41 a
	C-W	11.54 b	14.31	9.15	27.49	2.77 b	17 b
	C-GS	13.46 a	13.56	9.15	26.74	0.10 c	2 c
$LSD_{0.05}$		1.87	1.79	2.60	1.26	1.05	8
ANOVA (P > F)							
System		0.036	0.217	0.199	0.145	0.001	0.001
Wheat	C-W	11.53	11.53	8.05	21.99	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Sorghum	C-GS	10.73	15.78	12.24	21.42	5.04	34 a
	GS-GS	13.35	15.17	11.24	21.80	1.82	18 b
$LSD_{0.05}$		3.63	2.46	3.22	0.79	1.76	12
ANOVA (P > F)							
System		0.106	0.488	0.397	0.218	0.100	0.020

Note: All crops received ~10 inches of irrigation.
In-season rainfall for corn (4/29/2019 - 9/25/2019) = 12.35 inches; sorghum (6/10/2019 – 10/16/2019) = 8.03 inches; and wheat (9/19/2018 - 7/10/2019) = 16.89.
C = corn.
W = wheat.
GS = grain sorghum.
LSD = least significant difference.
ANOVA = analysis of variance.

Table 4. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation across years, Tribune, KS, 2013–2019

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	11.74	14.08 a	12.06 a	26.36	2.34 b	24 b
	C-W	11.23	14.08 a	11.83 a	26.59	2.85 a	19 b
	C-GS	10.88	12.58 b	10.53 b	26.39	1.70 c	33 a
$LSD_{(0.05)}$		0.84	0.64	0.79	0.63	0.44	6
ANOVA (P > F)							
System		0.128	0.001	0.001	0.732	0.001	0.001
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.001	0.001	0.004	0.002	0.001
Wheat	C-W	11.82	11.82	10.95	19.95	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Year		0.001	0.001	0.001	0.001	---	---
System × year		---	---	---	---	---	---
Sorghum	C-GS	10.19	13.62	11.82	23.45	3.43 a	29
	GS-GS	10.63	13.26	11.49	23.42	2.62 b	29
$LSD_{(0.05)}$		0.80	0.65	0.69	0.38	0.47	6
ANOVA (P > F)							
System		0.272	0.266	0.333	0.880	0.001	0.923
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.001	0.004	0.404	0.077	0.001

Note: All crops received ~10 inches of irrigation each year.
C = corn.
W = wheat.
GS = grain sorghum.
LSD = least significant difference.
ANOVA = analysis of variance.